

Serial No.: 10/028,040

Confirmation No.: 2997

Filed: December 21, 2001

For: METHODS FOR PLANARIZATION OF GROUP VIII METAL-CONTAINING SURFACES USING COMPLEXING AGENTS

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### Amendments to the Claims

This listing of claims replaces all prior versions, and listings, of claims in the above-identified application:

#### Listing of Claims

1. **(Currently Amended)** A planarization method comprising:
  - positioning a Group VIII metal-containing surface of a substrate to interface with a polishing surface, wherein the Group VIII metal is selected from the group of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;
  - supplying a planarization composition in proximity to the interface; and
  - planarizing the Group VIII metal-containing surface;
  - wherein the planarization composition comprises a complexing agent selected from the group of a cyclic diene, an organic [[alkyl]] amine, and combinations thereof;
  - and
  - wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.
2. **(Original)** The method of claim 1 wherein the Group VIII metal is present in an amount of about 50 atomic percent or more.
3. **(Original)** The method of claim 2 wherein the Group VIII metal-containing surface of the substrate comprises a Group VIII metal in elemental form or an alloy thereof.

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4. **(Original)** The method of claim 3 wherein the Group VIII metal-containing surface comprises elemental platinum or a platinum alloy.
5. **(Original)** The method of claim 4 wherein the Group VIII metal-containing surface comprises elemental platinum.
6. **(Currently Amended)** A planarization method comprising:
  - positioning a Group VIII metal-containing surface of a substrate to interface with a polishing surface, wherein the Group VIII metal is selected from the group of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;
  - supplying a planarization composition in proximity to the interface;
  - planarizing the Group VIII metal-containing surface;
  - wherein the planarization composition comprises about 0.1 wt-% to about 10 wt-% of a complexing agent selected from the group of a cyclic diene, an organic amine, and combinations thereof; and
  - wherein the planarization composition further comprises an oxidizing agent.
7. **(Original)** The method of claim 6 wherein the oxidizing agent is selected from the group consisting of a peroxide, a nitrate, a permanganate, and a combination thereof.
8. **(Original)** The method of claim 1 wherein the polishing surface comprises a polishing pad and the planarization composition comprises a plurality of abrasive particles.
9. **(Original)** The method of claim 1 wherein the planarization composition comprises a plurality of abrasive particles having a hardness of no greater than about 9 Mohs.

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10. **(Original)** The method of claim 9 wherein the plurality of abrasive particles comprise  $\text{CeO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ , or combinations thereof.
11. **(Original)** The method of claim 1 wherein the substrate is a semiconductor substrate or substrate assembly.
12. **(Original)** The method of claim 1 wherein the Group VIII metal-containing surface is removed relative to an oxide layer at a selectivity ratio of at least about 10:1.
13. **(Original)** The method of claim 1 wherein the cyclic diene is selected from the group consisting of 1,5-cyclooctadiene (COD), 1,5-dimethyl-1,5-cyclooctadiene, and a combination thereof.
14. **(Cancel)**
15. **(Original)** The method of claim 1 wherein the polishing surface comprises a fixed abrasive article.
16. **(Currently Amended)** A planarization method comprising:
  - positioning a Group VIII metal-containing surface of a substrate to interface with a polishing surface, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;
  - supplying a planarization composition in proximity to the interface; and
  - planarizing the Group VIII metal-containing surface;
  - wherein the planarization composition comprises an organic [[alkyl]] amine and an organic chelating acid or salt thereof; and

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wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.

17. **(Original)** The method of claim 16 wherein the Group VIII metal is present in an amount of about 50 atomic percent or more.
18. **(Original)** The method of claim 16 wherein the Group VIII metal-containing surface comprises elemental platinum.
19. **(Original)** The method of claim 16 wherein the planarization composition further comprises an oxidizing agent.
20. **(Original)** The method of claim 19 wherein the oxidizing agent is selected from the group consisting of a peroxide, a nitrate, a permanganate, and a combination thereof.
21. **(Original)** The method of claim 16 wherein the polishing surface comprises a polishing pad and the planarization composition comprises a plurality of abrasive particles.
22. **(Original)** The method of claim 16 wherein the planarization composition comprises a plurality of abrasive particles having a hardness of no greater than about 9 Mohs.
23. **(Original)** The method of claim 22 wherein the plurality of abrasive particles comprise  $\text{CeO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ , or combinations thereof.
24. **(Original)** The method of claim 16 wherein the substrate is a semiconductor substrate or substrate assembly.

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25. **(Original)** The method of claim 16 wherein the organic chelating acid is selected from the group consisting of acetic acid, ascorbic acid, citric acid, propenoic acid, tartaric acid, succinic acid, and combinations thereof.
26. **(Cancel)**
27. **(Original)** The method of claim 16 wherein the polishing surface comprises a fixed abrasive article.
28. **(Currently Amended)** A planarization method comprising:  
    positioning a Group VIII metal-containing surface of a substrate to interface with a polishing surface, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;  
    supplying a planarization composition in proximity to the interface; and  
    planarizing the Group VIII metal-containing surface;  
    wherein the planarization composition comprises a plurality of abrasive particles and a complexing agent; and further wherein a majority of the plurality of abrasive particles are CeO<sub>2</sub> abrasive particles;  
    wherein the complexing agent is selected from the group consisting of an organic chelating acid, an organic amine, a cyclic diene, and combinations thereof; and  
    wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.
29. **(Original)** The method of claim 28 wherein the Group VIII metal is present in an amount of about 50 atomic percent or more.

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30. **(Original)** The method of claim 28 wherein the Group VIII metal-containing surface comprises elemental ruthenium.
31. **(Original)** The method of claim 28 wherein the planarization composition further comprises an oxidizing agent.
32. **(Cancel)**
33. **(Currently Amended)** The method of claim ~~[[32]]~~28 wherein the organic chelating acid is selected from the group consisting of acetic acid, ascorbic acid, citric acid, propenoic acid, tartaric acid, succinic acid, and combinations thereof.
34. **(Cancel)**
35. **(Currently Amended)** The method of claim ~~[[32]]~~28 wherein the cyclic diene is selected from the group consisting of 1,5-cyclooctadiene (COD), 1,5-dimethyl-1,5-cyclooctadiene, and a combination thereof.
36. **(Original)** The method of claim 28 wherein the polishing surface comprises a polishing pad.
37. **(Currently Amended)** A planarization method comprising:
  - positioning a Group VIII metal-containing surface of a substrate to interface with a polishing surface, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;
  - supplying a planarization composition in proximity to the interface; and
  - planarizing the Group VIII metal-containing surface;

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wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, ~~an organic alkyl amine~~ ethylamine, methylamine, triethylamine, trimethylamine, acetic acid, ascorbic acid, propenoic acid, succinic acid, salts of the acids, and combinations thereof; and  
further wherein the method is carried out in one step.

38. **(Currently Amended)** A planarization method comprising:

positioning a Group VIII metal-containing surface of a substrate to interface with a polishing surface, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;  
supplying a planarization composition in proximity to the interface;  
planarizing the Group VIII metal-containing surface;  
wherein the planarization composition comprises about 0.1 wt-% to about 10 wt-% of a complexing agent selected from the group consisting of a cyclic diene, an organic amine, an organic chelating acid, and combinations thereof; [[and]]  
further wherein the method is carried out in one step; and  
wherein the planarization composition further comprises an oxidizing agent.

39. **(Currently Amended)** A planarization method comprising:

providing a semiconductor substrate or substrate assembly including at least one region of a platinum-containing surface;  
providing a polishing surface;  
providing a planarization composition at an interface between the at least one region of platinum-containing surface and the polishing surface;  
and  
planarizing the at least one region of platinum-containing surface;

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wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, an organic [[alkyl]] amine, and combinations thereof; and

wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.

40. **(Currently Amended)** A planarization method comprising:

providing a semiconductor substrate or substrate assembly including at least one region of a platinum-containing surface;

providing a polishing surface;

providing a planarization composition at an interface between the at least one region of platinum-containing surface and the polishing surface; and

planarizing the at least one region of platinum-containing surface;

wherein the planarization composition comprises about 0.1 wt-% to about 10 wt-% of a complexing agent selected from the group consisting of a cyclic diene, an organic amine, and combinations thereof; and

wherein the planarization composition further comprises an oxidizing agent.

41. **(Currently Amended)** A planarization method comprising:

providing a semiconductor substrate or substrate assembly including at least one region of a platinum-containing surface;

providing a polishing surface;

providing a planarization composition at an interface between the at least one region of platinum-containing surface and the polishing surface;

and

planarizing the at least one region of platinum-containing surface;



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wherein the planarization composition comprises an organic [[alkyl]] amine and an organic chelating acid or salt thereof; and

wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.

42. **(Original)** The method of claim 41 wherein the planarization composition further comprises an oxidizing agent.

43. **(Currently Amended)** A planarization method comprising:

providing a semiconductor substrate assembly including at least one region of a platinum-containing surface;

providing a polishing surface;

providing a planarization composition at an interface between the at least one region of platinum-containing surface and the polishing surface;

and

planarizing the at least one region of platinum-containing surface;

wherein the planarization composition comprises a plurality of abrasive particles and a complexing agent; and

further wherein a majority of the plurality of abrasive particles are CeO<sub>2</sub> abrasive particles;

wherein the complexing agent is selected from the group consisting of an organic chelating acid, an organic amine, a cyclic diene, and combinations thereof; and

wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.

44. **(Original)** The method of claim 43 wherein the planarization composition further comprises an oxidizing agent.

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45. **(Original)** The method of claim 43 wherein the polishing surface comprises a polishing pad.

46. **(Currently Amended)** A planarization method comprising:

providing a semiconductor substrate or substrate assembly including at least one region of a platinum-containing surface;

providing a polishing surface;

providing a planarization composition at an interface between the at least one region of platinum-containing surface and the polishing surface; and

planarizing the at least one region of platinum-containing surface;

wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, ~~an organic alkyl amine~~ ethylamine, methylamine, triethylamine, trimethylamine, acetic acid, ascorbic acid, propenoic acid, succinic acid, salts of the acids, and combinations thereof; and

further wherein the method is carried out in one step.

47. **(Currently Amended)** A planarization method comprising:

providing a semiconductor substrate or substrate assembly including at least one region of a platinum-containing surface;

providing a polishing surface;

providing a planarization composition at an interface between the at least one region of platinum-containing surface and the polishing surface; and

planarizing the at least one region of platinum-containing surface;

wherein the planarization composition comprises about 0.1 wt-% to about 10 wt-% of a complexing agent selected from the group consisting of a cyclic diene, an organic amine, an organic chelating acid, and combinations thereof;

further wherein the method is carried out in one step; and

wherein the planarization composition further comprises an oxidizing agent.

48. **(Currently Amended)** A planarization method for use in forming a capacitor or barrier layer, the method comprising:

providing a semiconductor substrate or substrate assembly having a patterned dielectric layer formed thereon and a Group VIII metal-containing layer formed over the patterned dielectric layer, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;

positioning a first portion of a polishing surface for contact with the Group VIII metal-containing layer;

providing a planarization composition in proximity to the contact between the polishing surface and the Group VIII metal-containing layer; and

planarizing the Group VIII metal-containing layer;

wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, an organic [[alkyl]] amine, and combinations thereof; and

wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.

49. **(Currently Amended)** A planarization method for use in forming a capacitor or barrier layer, the method comprising:

providing a semiconductor substrate or substrate assembly having a patterned dielectric layer formed thereon and a Group VIII metal-containing layer formed over the patterned dielectric layer, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;

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positioning a first portion of a polishing surface for contact with the Group VIII metal-containing layer;

providing a planarization composition in proximity to the contact between the polishing surface and the Group VIII metal-containing layer; and

planarizing the Group VIII metal-containing layer;

wherein the planarization composition comprises about 0.1 wt-% to about 10 wt-% of a complexing agent selected from the group consisting of a cyclic diene, an organic amine, and combinations thereof; and

wherein the planarization composition further comprises an oxidizing agent.

50. **(Currently Amended)** A planarization method for use in forming a capacitor or barrier layer, the method comprising:

providing a semiconductor substrate or substrate assembly having a patterned dielectric layer formed thereon and a Group VIII metal-containing layer formed over the patterned dielectric layer, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;

positioning a first portion of a polishing surface for contact with the Group VIII metal-containing layer;

providing a planarization composition in proximity to the contact between the polishing surface and the Group VIII metal-containing layer;

and

planarizing the Group VIII metal-containing layer;

wherein the planarization composition comprises an organic [[alkyl]] amine and an organic chelating acid or salt thereof; and

wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.

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51. **(Original)** The method of claim 50 wherein the planarization composition further comprises an oxidizing agent.

52. **(Currently Amended)** A planarization method for use in forming a capacitor or barrier layer, the method comprising:

providing a semiconductor substrate or substrate assembly having a patterned dielectric layer formed thereon and a Group VIII metal-containing layer formed over the patterned dielectric layer, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;

positioning a first portion of a polishing surface for contact with the Group VIII metal-containing layer;

providing a planarization composition in proximity to the contact between the polishing surface and the Group VIII metal-containing layer;

and

planarizing the Group VIII metal-containing layer;

wherein the planarization composition comprises a plurality of abrasive particles and a complexing agent; [[and]]

further wherein a majority of the plurality of abrasive particles are CeO<sub>2</sub> abrasive particles;

wherein the complexing agent is selected from the group consisting of an organic chelating acid, an organic amine, a cyclic diene, and combinations thereof; and

wherein the organic amine is selected from the group consisting of ethylamine, methylamine, triethylamine, trimethylamine, and combinations thereof.

53. **(Original)** The method of claim 52 wherein the planarization composition further comprises an oxidizing agent.

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54. **(Original)** The method of claim 52 wherein the polishing surface comprises a polishing pad.

55. **(Currently Amended)** A planarization method for use in forming a capacitor or barrier layer, the method comprising:

providing a semiconductor substrate or substrate assembly having a patterned dielectric layer formed thereon and a Group VIII metal-containing layer formed over the patterned dielectric layer, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;

positioning a first portion of a polishing surface for contact with the Group VIII metal-containing layer;

providing a planarization composition in proximity to the contact between the polishing surface and the Group VIII metal-containing layer;

and

planarizing the Group VIII metal-containing layer;

wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, ~~an organic alkyl amine~~ ethylamine, methylamine, triethylamine, trimethylamine, acetic acid, ascorbic acid, propenoic acid, succinic acid, salts of the acids, and combinations thereof; and

further wherein the method is carried out in one step.

56. **(Currently Amended)** A planarization method for use in forming a capacitor or barrier layer, the method comprising:

providing a semiconductor substrate or substrate assembly having a patterned dielectric layer formed thereon and a Group VIII metal-containing layer formed over the patterned dielectric layer, wherein the Group VIII metal is selected from the group

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consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;

positioning a first portion of a polishing surface for contact with the Group VIII metal-containing layer;

providing a planarization composition in proximity to the contact between the polishing surface and the Group VIII metal-containing layer; and

planarizing the Group VIII metal-containing layer;

wherein the planarization composition comprises about 0.1 wt-% to about 10 wt-% of a complexing agent selected from the group consisting of a cyclic diene, an organic amine, an organic chelating acid, and combinations thereof;

further wherein the method is carried out in one step; and

wherein the planarization composition further comprises an oxidizing agent.

57. **(Original)** The method of claim 55 wherein the polishing surface comprises a polishing pad.

58. **(Original)** The method of claim 55 wherein the polishing surface comprises a fixed abrasive article.

59. **(New)** A planarization method comprising:

positioning a Group VIII metal-containing surface of a substrate to interface with a polishing surface, wherein the Group VIII metal is selected from the group of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;

supplying a planarization composition in proximity to the interface;

planarizing the Group VIII metal-containing surface;

wherein the planarization composition comprises a complexing agent selected from the group of a cyclic diene, an organic amine, and combinations thereof; and

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wherein the planarization composition further comprises an oxidizing agent in an amount of no more than about 10 wt-%.

60. (New) The method of claim 59 wherein the complexing agent is present in an amount of no greater than about 10 wt-%.

61. (New) the method of claim 60 wherein the complexing agent is present in an amount of about 0.5 wt-% to about 5 wt-%.

62. (New) A planarization method comprising:

positioning a Group VIII metal-containing surface of a substrate to interface with a polishing surface, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;

supplying a planarization composition in proximity to the interface;

planarizing the Group VIII metal-containing surface;

wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, an organic amine, an organic chelating acid, and combinations thereof; and

wherein the planarization composition further comprises an oxidizing agent in an amount of no more than about 10 wt-%.

63. (New) The method of claim 62 wherein the oxidizing agent is present in an amount of about 0.1 wt-% to about 1 wt-%.

64. (New) The method of claim 62 wherein the complexing agent is present in an amount of no greater than about 10 wt-%.



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65. **(New)** the method of claim 64 wherein the complexing agent is present in an amount of about 0.5 wt-% to about 5 wt-%.
66. **(New)** A planarization method comprising:
- providing a semiconductor substrate or substrate assembly including at least one region of a platinum-containing surface;
  - providing a polishing surface;
  - providing a planarization composition at an interface between the at least one region of platinum-containing surface and the polishing surface; and
  - planarizing the at least one region of platinum-containing surface;
- wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, an organic amine, and combinations thereof; and
- wherein the planarization composition further comprises an oxidizing agent in an amount of no more than about 10 wt-%.
67. **(New)** The method of claim 66 wherein the complexing agent is present in an amount of no greater than about 10 wt-%.
68. **(New)** the method of claim 67 wherein the complexing agent is present in an amount of about 0.5 wt-% to about 5 wt-%.
69. **(New)** A planarization method comprising:
- providing a semiconductor substrate or substrate assembly including at least one region of a platinum-containing surface;
  - providing a polishing surface;

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providing a planarization composition at an interface between the at least one region of platinum-containing surface and the polishing surface; and

planarizing the at least one region of platinum-containing surface;

wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, an organic amine, an organic chelating acid, and combinations thereof; and

wherein the planarization composition further comprises an oxidizing agent in an amount of no more than about 10 wt-%.

70. **(New)** The method of claim 69 wherein the oxidizing agent is present in an amount of about 0.1 wt-% to about 1 wt-%.
71. **(New)** The method of claim 69 wherein the complexing agent is present in an amount of no greater than about 10 wt-%.
72. **(New)** the method of clam 71 wherein the complexing agent is present in an amount of about 0.5 wt-% to about 5 wt-%.
73. **(New)** A planarization method for use in forming a capacitor or barrier layer, the method comprising:
- providing a semiconductor substrate or substrate assembly having a patterned dielectric layer formed thereon and a Group VIII metal-containing layer formed over the patterned dielectric layer, wherein the Group VIII metal is selected from the group consisting of rhodium, iridium, ruthenium, osmium, palladium, platinum, and combinations thereof;
- positioning a first portion of a polishing surface for contact with the Group VIII metal-containing layer;

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providing a planarization composition in proximity to the contact between the polishing surface and the Group VIII metal-containing layer; and

planarizing the Group VIII metal-containing layer;

wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, an organic amine, and combinations thereof; and

wherein the planarization composition further comprises an oxidizing agent in an amount of no more than about 10 wt-%.

74. **(New)** The method of claim 73 wherein the complexing agent is present in an amount of no greater than about 10 wt-%.

75. **(New)** the method of claim 74 wherein the complexing agent is present in an amount of about 0.5 wt-% to about 5 wt-%.

76. **(New)** A planarization method for use in forming a capacitor or barrier layer, the method comprising:

providing a semiconductor substrate or substrate assembly having a patterned dielectric layer formed thereon and a platinum-containing layer formed over the patterned dielectric layer;

positioning a first portion of a polishing surface for contact with the platinum-containing layer;

providing a planarization composition in proximity to the contact between the polishing surface and the platinum-containing layer; and

planarizing the platinum-containing layer;

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wherein the planarization composition comprises a complexing agent selected from the group consisting of a cyclic diene, an organic amine, an organic chelating acid, and combinations thereof; and

wherein the planarization composition further comprises an oxidizing agent in an amount of no more than about 10 wt-%.

77. **(New)** The method of claim 76 wherein the oxidizing agent is present in an amount of about 0.1 wt-% to about 1 wt-%.
78. **(New)** The method of claim 76 wherein the complexing agent is present in an amount of no greater than about 10 wt-%.
79. **(New)** the method of clam 78 wherein the complexing agent is present in an amount of about 0.5 wt-% to about 5 wt-%.